Subject line: **UAE Mars Mission (w/ NASA) Discovers New Aurora on Mars**

Hello NAME, reaching out with some astronomy news re: a new discovery from the UAE's ongoing Emirates Mars Mission (EMM), the first interplanetary exploration undertaken by an Arab nation.

The news: the EMM, with support from NASA, discovered a new kind of 'patchy' Mars Proton Aurora. This new patchy type of proton aurora is formed when solar wind directly impacts Mars' dayside upper atmosphere and emits ultraviolet light as it slows down. Images providing context around the discovery can be found here.

When the aurora occurs, small regions of the planet become much brighter, signifying intense localized energy deposition in the atmosphere -- essentially creating a "map" of where the solar wind is raining down onto the planet, furthering our understanding of the Red Planet's atmosphere.

For context, the Emirates Mars Mission is studying the planet from its autonomous probe Hope to provide the international science community an unprecedented holistic view of the Martian atmosphere at different times of the day, through different seasons.

Today's discovery adds to a long list of new Martian phenomena EMM has observed, challenging our existing views on how proton auroras on Mars' dayside are formed -- and was made possible with local plasma observation information provided to the EMM team from NASA's MAVEN orbiter.

Click here to access available assets, including the full press release. If you'd be interested in an interview with the EMM science team, let me know and I'd be happy to coordinate.

Thanks XX!

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Press Release

Emirates Mars Mission Discovers New Kind of 'Patchy' Mars Proton Aurora

UAESA-NASA collaboration: EMM uncovers dayside aurora while MAVEN measures local space weather conditions

Dubai-UAE: 31 August 2022

The Emirates Mars Mission, the first interplanetary exploration undertaken by an Arab nation, has made first observations of a new type of proton aurora around Mars. The spatially variable 'patchy' proton aurora potentially triggers new insights into unexpected behaviours in the Martian atmosphere. The EMM team has worked together with NASA's MAVEN (Mars Atmosphere and Volatile EvolutioN) mission to fully characterise these observations. The combination of EMM's unprecedented global aurora images with MAVEN's simultaneous local plasma observations opens up new avenues for understanding the drivers of Mars' enigmatic aurora.

"Our discovery of these patchy proton aurora adds a new kind of event to the long list of those currently studied by EMM and challenges our existing views of how the proton aurora on Mars' dayside are formed," said Hessa Al Matroushi, EMM's Science Lead. "The EMM Hope probe has so far uncovered many unexpected phenomena that extend our understanding of Mars' atmospheric and magnetospheric dynamics. These new observations, combined with MAVEN data, have lifted the lid on entirely new possibilities for scientific research."

This new patchy type of proton aurora is formed when the solar wind directly impacts Mars' dayside upper atmosphere and emits ultraviolet light as it slows down. It was discovered in snapshots of the dayside disk obtained by the Emirates Mars Ultraviolet Spectrometer (EMUS), which observes the planet's upper atmosphere and exosphere, scanning for variability in atmospheric composition and atmospheric escape to space. The aurora manifests as bright regions scattered across the dayside of the planet in two

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ultraviolet wavelengths associated with the Hydrogen atom, Lyman beta at 102.6 nm and Lyman alpha at 121.6 nm. Under normal conditions, the dayside disk of the planet at these wavelengths is uniform, and the planetary brightness results from Hydrogen atoms scattering sunlight. When the aurora occurs, small regions of the planet become much brighter at these wavelengths, signifying intense localized energy deposition in the atmosphere.

“We’ve seen emissions at these wavelengths before, thanks to proton aurora studies by NASA’s MAVEN mission, but these EMM EMUS images represent the first time we’ve had a global view of spatial variability in proton aurora at Mars, and the first time we’ve been able to unambiguously observe this patchy structure,” said EMM science team member and lead author of a newly submitted paper on the proton aurora, Mike Chaffin. “We know that these wavelengths are only emitted by the Hydrogen atom, which tells us that super energetic Hydrogen atoms must be present in the atmosphere in order to produce the auroral emission.”

A data sharing agreement between EMM and MAVEN has enabled analysis of the new EMM images using plasma observations made by MAVEN, which has been characterizing the Mars ionosphere and magnetosphere since 2014. MAVEN carries a full suite of plasma instruments, including a magnetometer and two ion electrostatic analysers that measured the Martian plasma and fields environment during EMM’s observations of patchy proton aurora events.

“Multi-vantage point measurements of the Martian atmosphere tell us about the real time response of the atmosphere to the Sun. These types of simultaneous observations probe the fundamental physics of atmospheric dynamics and evolution”, said MAVEN Principal Investigator Shannon Curry.

“Access to MAVEN data has been essential for placing these new observations into a wider context. Together, we’re pushing the boundaries of our existing knowledge not only of Mars, but of planetary interactions with the solar wind,” said Al Matroushi.

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Martian proton auroras were originally discovered by MAVEN and subsequently found in data from ESA's Mars Express mission, but most of these previous observations show uniform auroral emission across the dayside of the planet. By contrast, the EMUS observations are able to unambiguously reveal small-scale spatial structure. Scientists from both teams now believe the patchy aurora can only be produced by plasma turbulence in the space surrounding Mars. "Because of the size scales involved in the solar wind and extended hydrogen atmosphere of Mars, there's no way the standard proton aurora formation mechanism could produce the aurora we're observing with EMUS," said Chaffin. "In the August 11 observations the aurora is so widespread and so disorganized that the plasma environment around Mars must have been truly disturbed. Thanks to MAVEN measurements of the Mars plasma environment simultaneous with the aurora, we can confidently say that the solar wind is directly impacting the upper atmosphere wherever we're seeing auroral emission," he added. "What we're seeing is essentially a map of where the solar wind is raining down onto the planet."

The simultaneous observations of patchy proton aurora by Hope and measurements of plasma conditions by MAVEN are therefore a window into rare circumstances, when the interaction between Mars and the solar wind is unusually chaotic.

Hope has observed patchy aurora multiple times over the course of its mission so far, and the shape of the aurora is not always the same. On 2021 August 30, for example, the patchy proton aurora was confined to a much smaller portion of the disk than on August 11, suggesting a different mechanism may be at work. Plasma turbulence at Mars can occur under a variety of conditions, and different shapes of patchy proton aurora may reveal different plasma conditions.

As of June 2022, Mars is about a month away from the peak of its Southern Summer, when proton aurora are known to be at their most active. "Whether we'll see anything as spectacular as what we've already got is anyone's guess, but I'm hopeful. Hope continues to far exceed our expectations for scientific discovery, and I can't wait to see what we learn next." said Chaffin.

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Hope's EMUS instrument (Emirates Mars Ultraviolet Spectrometer) measures the Martian disk in the far and extreme ultraviolet, its principal science goal being the measurement of oxygen and carbon monoxide in Mars' thermosphere and the variability of hydrogen and oxygen in the exosphere.

The high sensitivity of the spectrometer, required to enable detection of the distant oxygen corona, has resulted in EMUS being an extremely effective detector of auroral activity across the planet, unearthing new understandings of the nightside discrete aurora and the discovery of a completely new auroral phenomenon, the sinuous discrete aurora, which can stretch over halfway across the entire planet.

Hope is following its planned 20,000 – 43,000 km elliptical science orbit, with an inclination to Mars of 25 degrees. The probe completes one orbit of the planet every 55 hours and captures a full planetary data sample every nine days throughout its two-year mission to map Mars' atmospheric dynamics.

EMM and the Hope probe are the culmination of a knowledge transfer and development effort started in 2006, which has seen Emirati engineers working with partners around the world to develop the UAE's spacecraft design, engineering and manufacturing capabilities. Hope is a fully autonomous spacecraft, carrying three instruments to measure Mars' atmosphere. Weighing some 1,350 kg, and approximately the size of a small SUV, the spacecraft was designed and developed by MBRSC engineers working with academic partners, including LASP at the University of Colorado, Boulder; Arizona State University and the University of California, Berkeley.

The Emirates Mars Mission is studying the Martian atmosphere and the relationship between the upper layer and lower regions and, for the first time, gives the international science community full access to a holistic view of the Martian atmosphere at different times of the day, through different seasons. Science data releases have been taking place every three months, with the information made freely accessible globally to researchers and enthusiasts,

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The Hope Probe's historic arrival at the Red Planet coincided with a year of celebrations to mark the UAE's Golden Jubilee in 2021.

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About the Emirates Mars Mission

Announced in July 2014 by UAE President His Highness Sheikh Khalifa Bin Zayed Al Nahyan, and His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the United Arab Emirates and Ruler of Dubai, the Emirates Mars Mission was developed by the Mohammed Bin Rashid Space Centre (MBRSC), in conjunction with its knowledge transfer partners and funded by the UAE Space Agency.

Conceptualized to disrupt and accelerate the United Arab Emirates' space sector through shaping a scientific community, and boosting space education in the country, the Probe aims to build the first full picture of Mars's climate throughout the Martian year.

The Hope Probe reached Mars orbit in 2021, the 50th anniversary of the foundation of the UAE, which became an independent nation on December 2, 1971.

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IMAGE CAPTION

Comparison of normal and patchy proton aurora formation mechanisms at Mars.

The top image shows the normal proton aurora formation mechanism first observed in 2018. White lines show that solar wind protons traveling away from the Sun are normally swept around the planet by the Mars magnetosphere, and don't directly interact with the atmosphere. When proton auroras occur, a small fraction of the solar wind collides with hydrogen in the extended corona of the planet (shown in blue), and charge exchanges into neutral H atoms. These newly created H atoms are still travelling at the same speed, and are no longer sensitive to the magnetospheric forces that redirect protons around the planet. Instead, the energetic H atoms slam directly into the upper atmosphere of Mars and collide multiple times with the neutral atmosphere, resulting in auroral emission by the incident H atoms (purple). Because the solar wind and Mars corona are uniform across the planet, the aurora occurs everywhere on the planet's day side with a uniform brightness.

The bottom image shows the newly discovered formation mechanism for patchy proton aurora. Green lines in the top image show that under normal conditions the solar wind magnetic field drapes nicely around the planet. By contrast, patchy proton aurora form during unusual circumstances when the solar wind magnetic field is aligned with the proton flow. Under such conditions the typical draped magnetic field configuration is replaced by a highly variable patchwork of plasma structures, and the solar wind is able to directly impact the planet's upper atmosphere in specific locations that depend on the structure of the turbulence. When incoming solar wind protons collide with the neutral atmosphere, they can be neutralized and emit aurora in localized patches. During such times patchy proton aurora forms a map of the locations where solar wind plasma is directly impacting the planet.

Image Credit: Emirates Mars Mission/UAE Space Agency

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